The Effect of Hip Fracture on Mortality, Hospitalization, and Functional Status: A Prospective Study

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ABSTRACT

Objectives. The purpose of this study was to prospectively assess the independent effect of hip fracture on mortality, hospitalization, and functional status.

Methods. Among 7527 members of the Longitudinal Study of Aging who were over age 70 at baseline, 368 persons with hip fracture occurring between 1984 and 1991 were identified. Median length of follow-up was 831 days.

Results. Hip fracture was significantly related to mortality (adjusted hazards ratio [AHR] = 1.83; 95% confidence interval [CI] = 1.55, 2.16) when treated as a time-dependent covariate. This effect was concentrated in the first 6 months postfracture (AHR = 38.93, 95% CI = 29.58, 51.23, vs AHR = 1.17; 95% CI = 0.95, 1.44). Hip fracture significantly increased the likelihood of subsequent hospitalization (adjusted odds ratio = 3.31, 95% CI = 2.64, 4.15) and increased the number of subsequent episodes by 9.4%, the number of hospital days by 21.3%, and total charges by 16.3%. Hip fracture also increased the number of functional status dependencies.

Conclusions. The health of older adults deteriorates after hip fracture, and efforts to reduce the incidence of hip fracture could lower subsequent mortality, morbidity, and health services use. (*Am J Public Health.* 1997;87:398–403)

Introduction

In 1994 the Office of Technology Assessment issued a landmark report that comprehensively reviewed the literature on the mortality, in-hospital and posthospital service use, and long-term functional improvement associated with hip fracture.[1] It concluded that 94% of the nearly 300 000 hip fractures that occurred in the United States in 1990 involved adults aged 50 years or older. Nearly all of these required hospitalization, and the estimated mean hospital charges were $9322. Inpatient mortality was approximately 4%, and about 39% of patients were discharged to a long-term care facility. Estimated mean posthospital and other expenditures (including nursing home charges) were $9852. The 1-year postfracture mortality rate was approximately 24%. Among those who survived, most did not return to their prefracture functional status, and their recovery trajectory peaked by 6 months postfracture. Accordingly, a key target in federal health care policy is the reduction of the incidence of hip fracture among older adults.[2]

Despite the critical importance of hip fracture and the comprehensive review of the literature in the Office of Technology Assessment report,[1] the current knowledge base remains inadequate. Four limitations of previous studies account for this. First, no national studies have been conducted. Second, there have been few prospective studies. Third, appropriate comparison groups have seldom been used. Finally, most reports have been descriptive, and they have not involved multivariable analyses.

The purpose of this paper is to prospectively assess the independent effect of hip fracture on mortality, hospitalization, and functional status among the 7527 older adults included in the nationally representative Longitudinal Study of Aging (LSOA). To control for potential confounders, a variety of covariates are included on the first step of the hierarchical models. Proportional hazards analysis is used to estimate the effect of hip fracture on mortality. Multivariable logistic regression is used to estimate the effects of hip fracture on whether any subsequent hospitalization occurred. Multivariable linear regression is used to estimate, among those with subsequent hospitalizations, the effect of hip fracture on the number of subsequent hospitalizations, total number of hospital days, and total charges. Multivariable linear regression is also used to estimate the effect of hip fracture on changes in functional status between 1984 and 1990 among survivors.

Methods

Sample

The LSOA is the follow-up to the Supplement on Aging (96.0% participa-

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tion rate) appended to the 1984 National Health Interview Survey (96.4% participation rate). It consists of the 7527 Supplement on Aging respondents aged 70 years or older in 1984 (96.6% of all National Health Interview Survey respondents in that age range) who were selected for follow-up interviews in 1986, 1988, and 1990 and to have their Medicare Automated Data Retrieval System (MADRS) hospitalization records and National Death Index data abstracted for calendar years 1984 through 1991. After these files were linked, hospitalization episodes that contained the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD9-CM)[3] codes for hip fracture (i.e., 820.0 through 820.9) in any of the five discharge diagnosis fields were used to identify the 368 hip fracture patients. For those with multiple hip fracture episodes, the first was chosen as the index case. Consistent with previous reports on the incidence[4] and recurrence[5] of hip fracture using this data set, the unweighted LSOA data are used without adjustments for design effects.[6–10]

Covariates

To obtain the independent effect of hip fracture on mortality, hospitalization, and functional status, it is necessary to statistically control for potentially confounding factors. Previous studies of the LSOA[10–13] have shown these outcomes to be related in part to factors identified in the behavioral model of health services utilization,[14] which is the most widely used multivariable framework for studying health and health behavior.[15] Basically, it views the use of health services as a function of the predisposing, enabling, and need characteristics of the individual, as well as the individual's prior utilization history. The measures of the predisposing characteristics used here include age, sex, race, education, two variables reflecting living arrangements (living alone or in multigenerational households), and separate kin and nonkin support scales. The enabling characteristics were represented by having private health insurance for *both* physician and hospital expenses, being on Medicaid, residential stability (had not moved in 5 years), population density (the 10-point county adjacency scale), financial dependence on Social Security, and three variables reflecting geographic region.

There were 25 measures of need characteristics. Four decomposed the traditional measure of perceived health status. The next 11 were dichotomous variables indicating whether or not the respondent had ever had osteoporosis, a broken hip, atherosclerosis, hypertension, coronary heart disease, angina, myocardial infarction, any other heart attack, stroke or a cerebrovascular accident, Alzheimer's disease, or cancer. There were also five dichotomous variables indicating whether or not the respondent had had arthritis, diabetes, an aneurysm, a

TABLE 1—Means (or Proportions) of the Covariates for Hip Fracture Patients (n = 368) and the Control Subjects (n = 7159)

	Hip Fracture Patients	Control Subjects	P[a]
Predisposing characteristics			
Age, y	79.66	76.68	.0001
Sex, % female	77.99	61.17	.0001
Race, % Black	2.99	8.90	.0001
Education, y	10.15	9.99	.4148
Living alone, %	47.01	35.90	.0001
Living in multigenerational household, %	16.85	17.69	.6786
Kin supports, no. sources	1.62	1.61	.9529
Nonkin supports, no. sources	2.23	2.39	.2426
Enabling characteristics			
Private insurance, %	64.67	66.77	.4057
Medicaid, %	4.62	5.64	.4075
Residentially stable, %	83.15	84.25	.5728
Population density[b]	2.61	2.60	.9125
Social Security dependence, %	66.85	64.18	.2978
Living in Northeast, %	21.20	23.15	.3861
Living in North Central, %	27.99	25.66	.3201
Living in West, %	16.85	17.64	.6985
Need characteristics			
Very good health, %	20.92	20.14	.7148
Good health, %	29.62	31.52	.4427
Fair health, %	22.28	21.26	.6400
Poor health, %	13.04	11.76	.4579
Osteoporosis, %	4.62	3.61	.3136
Broken hip, %	8.70	4.22	.0001
Atherosclerosis, %	12.77	12.91	.9389
Hypertension, %	44.29	44.98	.7965
Coronary heart disease, %	4.08	4.49	.7082
Angina, %	6.79	6.94	.9158
Myocardial infarction, %	0.82	1.97	.1144
Other heart attack, %	7.34	6.91	.7526
Stroke or cerebrovascular accident, %	6.25	7.47	.3841
Alzheimer's disease, %	0.27	0.57	.4489
Cancer, %	12.50	12.17	.8493
Arthritis, %	57.07	53.93	.2392
Diabetes, %	6.52	10.00	.0288
Aneurysm, %	0.54	0.55	.9960
Blood clot, %	2.17	1.52	.3263
Varicose veins, %	9.78	9.90	.9403
Basic ADLs, no. difficulties	0.78	0.68	.0719
Household ADLs, no. difficulties	0.69	0.59	.0628
Advanced ADLs, no. difficulties	0.18	0.15	.0120
Lower-body limitations, no.	2.13	1.84	.0126
Upper-body limitations, no.	0.49	0.42	.5287
Baseline health services utilization			
Hospital contact, %	28.26	20.88	.0007
Physician visits, no.	4.63	4.21	.0543
Nursing home placement, %	3.26	2.60	.4410

Note. ADLs = activities of daily living.
[a]Based on one-way analysis of variance for interval variables and chi-square test for nominal variables.
[b]0 = large standard metropolitan statistical area; 9 = rural county.

TABLE 2—Mortality and Hospitalization Rates for Hip Fracture Patients and the Control Subjects

Outcome	Hip Fracture Patients	Control Subjects	*P*
Mortality			
Events/persons (%)	157/368 (43)	2706/7159 (38)	.0635[a]
Events/person-years (rate)	157/2570 (.061)	2706/47416 (.057)	.4394[b]
Hospitalization			
Any episodes, events/persons (%)	239/368 (65)	2752/7159 (38)	.0001[a]
Mean no. episodes[c]	2.3	2.0	.0016[d]
Mean no. days[c]	22.7	18.1	.0187[d]
Mean charges,[c] $	18 105	16 422	.2545[d]

[a]Based on chi-square test.
[b]Based on univariable proportional hazards model.
[c]Among the 2993 persons with one or more episodes.
[d]Based on one-way analysis of variance.

blood clot, or varicose veins during the 12 months prior to baseline.

The five remaining measures of need characteristics were previously validated[7,11,16,17] multiple-item scales that consist of various measures of disability in activities of daily living. The basic activities-of-daily-living scale (alpha = .860) reflects difficulties with six items taken from the Katz scale (i.e., bathing, dressing, getting out of bed, toileting, getting outside, and walking).[18] The household activities-of-daily-living scale (alpha = .821) reflects difficulties with four items taken from Duke University's scale (i.e., meal preparation, shopping, and light and heavy housework).[19] The advanced (or cognitive) activities-of-daily-living scale (alpha = .638) reflects difficulties with managing money, using the telephone, and eating.[18,19] The two remaining scales were drawn from standard disability items.[20] One taps lower-body limitations (alpha = .862), such as difficulties in walking a quarter of a mile; walking up 10 steps without rest; standing or being on one's feet for 2 hours; stooping, crouching, or kneeling; and lifting or carrying 25 pounds. The other taps upper-body limitations (alpha = .577), such as difficulties in sitting for 2 hours, reaching up over the head, reaching out as if to shake hands, and using fingers to grasp objects.

Baseline health services utilization was represented by three measures. One was a dichotomous indicator of whether the respondent had been hospitalized during the 12 months prior to baseline. The second was the number of physician visits that occurred during the 12 months prior to baseline. The third was a dichotomous indicator of whether the respondent had ever been placed in a nursing home prior to baseline.

The Simulated Hip Fracture Date

To estimate the effect on subsequent hospitalizations it was necessary to simulate a hip fracture date for the control subjects. This simulation involved several steps. First, all hospital discharge dates were converted to a day count with the base of January 1, 1984, set to 1. Second, the distribution of those day counts for hospital episodes involving a hip fracture was examined and found to have a mean of 1600 and a standard deviation of 800. Third, a random variable (the simulated hip fracture date) constrained to have the same mean and standard deviation was generated for all hospital discharges. Fourth, a paired t test comparing the simulated hip fracture date with the actual hip fracture date among the 368 hip fracture patients was performed. The mean difference was 8 days (SE = 49, $P = .87$), indicating no difference between the observed and simulated dates. Accordingly, the observed hip fracture discharge date is used as the index discharge date for the hip fracture patients, and the simulated hip fracture date is used as the index discharge date for the control subjects.

Outcomes

Mortality status and date of death were taken from the National Death Index. Subsequent hospitalization data were obtained by aggregating the MADRS episode records forward from the actual or simulated hip fracture discharge date through December 31, 1991. These data were then used to construct a dichotomous indicator of whether any subsequent hospitalizations had occurred and, among those with subsequent hospitalizations, the total number of episodes, total number of hospital days, and total charges. Because of their positively skewed distributions, the natural logarithms (+1) are used in the multivariable analysis. Changes in the number of limitations on the five functional health status scales were obtained by subtracting the 1984 from the 1990 counts among those successfully reinterviewed in 1990. The potential for ceiling and floor effects in assessing changes in these functional status measures has been examined elsewhere[10] and found not to be a problem. Similarly, alternative methods for assessing changes in these functional status measures have been examined elsewhere[10] and found to yield equivalent results.

Statistical Analysis

Two-step hierarchical models were used to obtain the independent contribution of having suffered a hip fracture. On the first step the 44 predisposing, enabling, need, and prior utilization covariates were entered. A dichotomous marker for having suffered a hip fracture was introduced on the second step. All statistical analyses were performed with SPSS for Windows, version 6.1.2S.[21]

Results

Descriptive Data

To characterize the sample at baseline, Table 1 contains the means (or proportions) of the 44 covariates for the hip fracture patients and the control subjects. In general agreement with previous reports,[1] the hip fracture patients were significantly ($P \leq .05$) more likely than the control subjects to be older, female, and White and to live alone, to have fractured a hip previously, to not have had diabetes, to have more difficulties with advanced activities of daily living, to have more lower body limitations, and to have been hospitalized in the year prior to baseline.

Table 2 contains crude rates for mortality and hospitalization for the hip fracture patients and the control subjects. Initial analyses did not indicate a significant difference in mortality over the 8-year period, even though 43% of the hip fracture patients died vs 38% of the control subjects, yielding a mortality rate

TABLE 3—Mean Increases in Number of Functional Health Status Limitations between 1984 and 1990 among the 4138 Persons Reinterviewed in 1990

Functional Health Status Limitations	Hip Fracture Patients (n = 108)	Control Subjects (n = 4030)	*P*
Basic ADLs	2.08	.79	.0001
Household ADLs	.89	.45	.0001
Advanced ADLs	.44	.26	.0002
Lower-body limitations	1.75	.75	.0001
Upper-body limitations	.50	.27	.0012

Note. The 89 persons with hip fractures occurring in 1990 or 1991 are classified as control subjects in these analyses. ADLs = activities of daily living.

of .061 vs .057. Visual inspection of the cumulative survival distribution among the hip fracture patients (data not shown), however, revealed a substantial short-term mortality risk, such that about 20% of these patients were dead within 1 year postfracture. This suggested reanalysis using a proportional hazards model in which hip fracture was treated as a time-dependent covariate, along with subsequent stratification based on postfracture survival time. The initial time-dependent covariate analysis yielded a crude relative risk ratio (RR) of 2.42 (95% confidence interval [CI] = 2.06, 2.85), and the stratified analyses further revealed the concentration of that mortality hazard in the first 6 months postfracture (RR = 57.36; 95% CI = 43.67, 75.33) rather than subsequently (RR = 1.57; 95% CI = 1.28, 1.92). Median length of postfracture follow-up among hip fracture patients was 831 days (415 days for decedents and 1099 days for survivors).

The hip fracture patients were significantly more likely than the control subjects to have subsequent MADRS hospitalizations (65% vs 38%). When the volume of hospital resource consumption is examined for the 2993 persons with one or more MADRS hospitalizations after their actual or simulated hip fracture date, two significant differences emerge. The hip fracture patients experienced about 2.3 hospital episodes vs 2.0 for control subjects, and they had about 4.6 more hospital days (22.7 vs 18.1). Although mean total hospital charges were also higher for hip fracture patients than for control subjects ($18 105 vs $16 422), this difference was not significant.

Table 3 shows mean increases in the number of functional health status limitations between 1984 and 1990 for the hip fracture patients and control subjects. Significant mean increases on all five scales are associated with having suffered a hip fracture between 1984 and 1989. These mean increases represent the average number of new functional limitations incurred over the 6-year period. The differences in mean increases are 1.29 on basic activities of daily living, .44 on household activities of daily living, .18 on advanced activities of daily living, 1.00 on lower-body limitations, and .23 on upper-body limitations.

Modeling Mortality and Subsequent Hospitalization

When the hip fracture marker was entered as a time-dependent covariate on the second step of the proportional hazards analysis of mortality over the 8-year period, it had a highly significant effect (adjusted hazards ratio [AHR] = 1.83; 95% CI = 1.55, 2.16). The stratified analyses once again revealed that the effect was concentrated in the first 6 months postfracture (AHR = 38.93, 95% CI = 29.58, 51.23, vs AHR = 1.17, 95% CI = 0.95, 1.44). When the hip fracture marker was entered on the second step of the logistic regression model predicting having any hospital episodes after the actual or simulated hip fracture date, its effect was also quite significant, yielding an adjusted odds ratio of 3.31 (95% CI = 2.64, 4.15). Multiple linear regression was used to assess the independent effect of hip fracture on the three measures of volume of subsequent hospitalization among the 2993 persons who had one or more episodes after their actual or simulated hip fracture date. The percentage increase in these volume measures was calculated by subtracting 1 from the exponent of the partial unstandardized regression coefficients (data not shown) for hip fracture and multiplying by 100.[22] Having suffered a hip fracture significantly increased the number of subsequent episodes (an increase of 9.4%; *P* = .0007), the total number of hospital days (an increase of 21.3%; *P* = .0016), and the total charges (an increase of 16.3%; *P* = .0366).

TABLE 4—Partial, Unstandardized Linear Regression Coefficients (b's) for the Effects of Hip Fracture on Change in Functional Status Limitations between 1984 and 1990 among the 4138 Persons Reinterviewed in 1990[a,b]

Functional Status Change in . . .	b	*P*
Basic ADLs	1.12	.0001
Household ADLs	.35	.0019
Advanced ADLs	.21	.0008
Lower body limitations	.93	.0001
Upper body limitations	.26	.0223

Note. The analysis controlled for the 44 predisposing, enabling, need, and health services utilization characteristics measured at baseline (see Table 1). The 89 persons with hip fractures occurring in 1990 or 1991 are classified as control subjects in these analyses. ADLs = activities of daily living.

Modeling Functional Status

Table 4 shows the partial, unstandardized linear regression coefficients (b's) for the hip fracture marker and their *P* values on the changes in each of the functional status scales. Here, the b's may be interpreted as the regression-adjusted mean changes in the number of functional limitations independently associated with having suffered a hip fracture.[23] Among the 4138 persons reinterviewed in 1990, having suffered a hip fracture significantly increased the number of difficulties in basic activities of daily living (by 1.12), the number of difficulties in household activities of daily living (by .35), the number of difficulties in advanced activities of daily living (by .21), the number of lower-body limitations (by .93), and the number of upper-body limitations (by .26).

Discussion

This study assessed the effect of hip fracture on mortality, hospitalization, and functional status. Several features distinguish this study from previous efforts: (1)

a large, nationally representative sample was used; (2) an appropriate comparison group was provided; (3) subjects were followed prospectively for up to 8 years; and (4) the study focused on the independent effects of hip fracture by controlling for numerous potentially confounding covariates.

A number of statistically significant and clinically relevant effects were detected. Having suffered a hip fracture significantly increased the likelihood of dying (by 83%) and the likelihood of having any subsequent hospital episodes (by 231%). Among those who had one or more hospital episodes after their actual or simulated hip fracture date, having suffered a hip fracture significantly increased the number of subsequent episodes (by 9.4%), the total number of hospital days (by 21.3%), and the total charges (by 16.3%). For persons reinterviewed in 1990, having suffered a hip fracture significantly increased (from their 1984 levels) the number of difficulties in basic activities of daily living (by 1.12), the number of difficulties in household activities of daily living (by .35), the number of difficulties in advanced activities of daily living (by .21), the number of lower-body limitations (by .93), and the number of upper-body limitations (by .26). All of these independent effects of hip fracture are consistent in direction and, generally, in magnitude with the more crude effects reported in previous studies.[1]

It is important to note that the previously reported effect of hip fracture on mortality[1] was found only when hip fracture was treated as a time-dependent covariate in the proportional hazards analysis, and that the stratified analyses revealed that the effect was concentrated in the first 6 months postfracture. This is consistent with the fact that the cumulative survival distribution (data not shown) for the hip fracture patients falls precipitously immediately after the event but returns to a course nearly parallel to that for the control subjects by 6 months postfracture. This explains why earlier reports based on the first year or less of follow-up after hip fracture found considerable increases in mortality rates,[1] but the initial analyses reported here (which did not treat hip fracture as a time-dependent covariate) over the 8-year period did not.

Given the evidence from this and previous studies, there can be little doubt that after older adults suffer hip fractures, their health and health behavior deteriorates. What is not clear, however, is whether hip fracture is the sentinel event that initiates this process or merely a marker showing that it has already begun. To choose between these alternatives, the pre–hip fracture (actual or simulated) health status and hospital resource consumption trajectories must first be incorporated into the multivariable models. Then the post–hip fracture (actual or simulated) trajectories must be demonstrated to be significantly steeper among those who actually suffered a hip fracture. Further research is also needed to examine what, if anything, predicts the slope of the post–hip fracture trajectory.

The need for further research notwithstanding, the results reported here underscore the importance of achieving the public health policy objective of reducing the incidence of hip fracture among older adults.[2] Although the most efficient, effective, and executable methods of doing that have not been determined, growing evidence points to three likely candidates. One of these involves the reduction of injurious falls,[24] regardless of whether this is achieved by a well-coordinated and multidimensional intervention,[25] a targeted physician's assessment of clinical risk factors that can be readily performed in the typical office setting,[26] or physicians' simply asking their patients whether they have fallen at all since their last visit.[27] Another involves increasing bone mineral density by encouraging lifelong calcium intake, supplementing postmenopausal calcium intake, and prescribing hormonal replacement therapy.[28] A third involves minimizing the likelihood of falling directly on the hip by nutritional repletion and exercise interventions to increase muscle strength, neuromuscular function, and gait[29,30] or by dissipating the impact of such high-risk falls with trochanteric padding.[31] Physicians caring for older adults are urged to consider all three methods. □

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